



Inspection of Water Storage Facilities

Water Protection Program technical bulletin

4/2004

A technical bulletin, *Microbial Contamination of Water Storage Tanks* (pub172), was issued September 1995, because of too many occurrences of microbial contamination of water storage facilities and because of failure to inspect or inadequate inspection of water storage facilities. Today, the occurrence of microbial contamination is lower because more tanks are being inspected, but the quality of inspections varies widely. Too many inspection services look only at the condition of the paint and ignore other important issues. These inspections may fail to reveal major sanitary defects in water storage facilities while giving a false belief in the integrity of the storage facility. Currently, no certification of water storage inspectors exists and the qualifications of inspectors vary widely. The department is issuing this bulletin to aid water system officials in assuring proper inspection of their storage facilities and to secure some uniformity in the reports submitted to officials by inspecting firms. This bulletin is not intended to be a definitive reference concerning the construction, operation and maintenance of steel water storage tanks. Those wanting more information concerning these issues may wish to refer to the American Water Works Association's Manual M42, *Steel Water Storage Tanks*, or to publications of the Steel Plate Fabricators Association.

The following information is only for guidance and covers all types of finished water storage facility inspections.

General

The items on finished water storage facilities that must be inspected can be divided into five categories:

1. Sanitary conditions
2. Structural and footing conditions
3. Safety and security conditions
4. Coating system conditions
5. General details.

Sanitary conditions are those that could allow contamination of the water in storage. Structural and footing conditions are those that can affect the structural integrity of the storage facility. Safety and security conditions are those affecting the equipment that enables or protects inspectors and maintenance workers and prevents access to the tank by unauthorized people. Coating system conditions are those affecting the interior and exterior paint. General details are information on the storage facility such as overflow height, tank dimensions, overflow pipe size and other construction features. This information must be readily available, up-to-date, accurate and confirm as-built data to prevent costly mistakes when constructing additional storage facilities or major expansions to the water system, and to facilitate inspections, maintenance or emergencies.



Inspector Qualifications

Only organizations and individuals knowledgeable and equipped to do the work should do inspections. It is extremely important that inspectors have a thorough knowledge of water storage construction and be able to recognize improperly maintained or constructed vents, overflows, roof hatches, etc. Furthermore, inspectors must be thoroughly familiar with all the different safety equipment installed on storage facilities and with current safety standards. Any inspection service should be willing to explain the qualifications of their inspectors. Also, any firm should be willing to provide inspection checklists or copies of reports that show they can and will inspect facilities for sanitary defects and structural damage as well as paint condition.

The inspection firm or inspector shall carry adequate workman's compensation, property damage and public liability insurance and shall fully protect the owner against claims of any nature arising out of the inspection work.

Inspection Services

Ideally, the inspection firm should be a neutral third party that is not involved in storage facility maintenance, painting or repair. No inspection should be done without a written contract or agreement between the system and the inspection firm. This contract should clearly state the type and scope of the inspection to be provided and of any other services that will or will not be provided. For example, some firms do not provide repairs of steel and equipment or painting services. Also, it should state what equipment, material and services the system will provide, and what the inspection firm will provide. For example, who will provide pressure relief valves, pressure tanks and other equipment needed to isolate the storage facility during an inspection? Furthermore, the contract must state who is responsible for disinfecting the storage facility after the inspection and state the disinfection method to be used. The contract must require sufficient advance notice so that the water storage facility can be drained for the inspection.

In water systems having only one storage tank, consideration should be given to leasing a portable pressure tank to stabilize pressure, to minimize wasting water and to prevent main breaks. Some inspection firms have these tanks available as part of their service.

The inspection firm should provide all necessary personal safety equipment for its inspectors and assume the entire responsibility for accident to its employees while inspecting the structure. The inspectors must make such observations of ladders, railings, roof rods and other parts of the structure necessary to determine their safety for use while inspecting the structure.

Inspection Report

All inspection firms should provide quality videotapes or pictures of the facility and written reports describing all the inspection findings. These written reports shall be detailed and describe all conditions discovered during an inspection and not just the deficiencies. Do not assume that anything not mentioned in the report is in good condition. Furthermore, the report must provide enough information on any deficiencies found that system officials can make informed decisions as to actions that must be taken and their timing.

The report must include the inspector's professional evaluation of the general conditions and specific deficiencies found and recommend actions for correcting the deficiencies. Any sanitary defect, contamination, safety hazard or serious structural damage found should be reported at the time of the inspection so the facility owner can have them corrected immediately. Furthermore, these serious conditions shall be included in the written report.

Cleanliness and Cleaning

The inspector shall conduct all his work in a clean and sanitary manner and shall be responsible for cleaning all surfaces thoroughly before a storage facility is returned to service. Any time exterior repairs are done that could affect the quality of the water in a facility or work is done in a storage facility interior, the storage facility must be cleaned and disinfected before it is returned to service. State rule 10 CSR 60-4.080(6) requires public water systems to disinfect every newly repaired finished water storage facility by methods acceptable to the Department of Natural Resources before returning it to service. The department accepts the methods described in ANSI/AWWA Standard C652-92 for Disinfection of Water-Storage Facilities. However, the department accept only the membrane-filter technique for coliform analysis [the State Laboratory now does the membrane-filter technique only when specifically requested]. Ultimately, it is the responsibility of the tank owner to either conduct or require water quality tests to demonstrate the good sanitary condition of the tank interior.

When cleaning or disinfecting a storage facility, follow all environmental laws and rules to dispose of the chlorinated water, sludge, debris and other waste. Before the work begins, the facility owner and the inspection firm must make arrangements to properly handle and dispose of these. Frequently these wastes are dumped to sanitary sewers. However, strong chlorine residuals or heavy solids may cause sewer plugging and treatment problems. In addition, hydraulic limitations may exist in some sewer systems. Therefore, make all necessary agreements and arrangements with wastewater system operating authority before dumping anything.

What You Should Inspect

The following are lists of the minimum things that should be inspected during a water storage facility inspection. These lists are not all inclusive and the items requiring inspection depends somewhat on the design of a storage facility.

Sanitary conditions:

Birds, bats, bees, wasps and unidentifiable animals entering and contaminating storage facilities have caused water borne disease outbreaks and boil water notices on radio and TV. Water in storage facilities has also been contaminated by bird droppings and dirt washed into facilities by precipitation. Therefore, any sanitary defect found should be immediately brought to the attention of the facility owner so it can be quickly corrected.

1. The roof and side walls of all structures must be watertight with no openings except properly constructed vents, manways, overflows, cathodic protection equipment, risers, drains, pump mountings, control ports or piping for inflow and outflow. No unprotected opening between the walls and roof is permissible.
2. Any openings in a roof must be curbed (four to six inches) or sleeved with proper additional shielding to prevent precipitation and surface or floor drainage water from getting into the structure.
3. Roof access hatches must have watertight covers that overlap the framed opening and extend down around the frame at least two inches. The covers must be hinged on one side and have a locking device. All hatches should be checked to assure proper operation and fit.
4. Water storage roofs must be well drained and not tend to hold water. Low spots or structures that hold water must be corrected.

5. All finished water storage facilities must be properly vented and overflows cannot be used as vents.
6. Vent construction must prevent the entrance of surface water and rainwater and exclude birds, animals and insects. Vents must be screened with No.18 mesh, non-corroding material.
7. Vents must be designed so they do not become bird roosts and bird droppings cannot enter the storage facility through the vent by washing, falling or being inhaled. The old style ball and finial type vents do not meet these requirements.
8. Vents must be sized adequately to prevent differential pressures between the inside and outside of the storage facility.
9. Vents must be constructed to prevent frosting of the screens or provided with vacuum valves or failsafe devices.
10. Overflows on elevated tanks, standpipes and tall ground storage facilities must discharge at an elevation no higher than 12 to 24 inches above ground and discharge into or onto a drainage inlet structure or splash plate.
11. Overflows must be sized to carry more than the largest filling rate of the storage facility.
12. Overflows cannot be directly connected to sewers or drains.
13. Overflows must be screened or equipped with a flap valve to prevent the entrance of birds, animals and insects. Flap valves must be designed so they close completely and cannot high center and stick open.
14. Brackets connecting overflow piping to the structure must be checked to assure they are secure to both the structure and the overflow pipe and that they are not damaged by corrosion.
15. If water stands stagnant or silt collects in the bottom of a tank bowl, the tank must be modified to minimize this or provided with siphon drains or freeze proof direct drains. The water and deposits must be removed periodically to prevent microbial growths, to minimize corrosion and to prevent the deposits from going into the distribution system.
16. Check for evidence of contamination of the storage interior.
17. Hydrants, cleanouts or similar flushing devices must be provided on the piping of all water towers, standpipes and ground storage tanks. These devices must be located so that they can drain the storage facility while it is isolated from the system. Flushing devices on separate lines that are directly connected to the storage facility are acceptable substitutes but valves or plugs installed in wet risers or standpipes are not acceptable.
18. Taps or sampling stations suitable for collecting microbiological samples must be provided on the discharge piping of each storage facility. These must be located so that water directly from the storage facility can be sampled.

Structural conditions:

In the event that significant structural defects are identified, public water system officials should consult with a Missouri registered professional engineer to evaluate the inspection findings and recommendations. Some inspection firms will provide this service if it is specifically requested.

1. Are anchor bolts rusted enough to materially reduce their strength?
2. Are anchor bolts tight? Has dirt, grass or weeds accumulated on the anchor bolts?
3. Are column shoes clean and painted?
4. What is the condition of the grout under the column shoes and riser plate?
5. Does dirt, grass or weeds accumulate on the column shoes or riser plate?
6. Is there any indication of settlement of column or riser foundations?
7. Do areas exist where water pools or erosion has occurred around the foundations?
8. Do the foundations extend far enough above ground level to protect the column shoes and riser plates from excessive moisture and corrosion?
9. What is the physical condition of the concrete foundations?
10. Are the wind rods in good condition and properly tightened?
11. Where the wind rod connecting pins are secured with cotter pins or welded washers, check each connecting pin and report any missing cotter pins or washers.
12. Where the wind rod connecting pins are secured with nuts, check to make sure that each nut is full threaded and the thread is well battered.
13. Are the leg struts and their connections in good condition?
14. Is the riser straight and are the riser pipe stay rods in good condition?
15. Check the entire structure for water leaks including all manways, risers and tower legs.
16. Check all welds and seams for cracks.
17. Check all bolts and rivets for corrosion and leaks.
18. Older style elevated tanks with spider rods and hubs should have these removed and replaced with a stiffener ring welded around the upper perimeter of the tank wall.
19. Check to see that all cables, conduits, antennae and similar devices are properly secured to the storage structures
20. All roof trusses, rafters and their connections must be checked for ice damage, corrosion

and soundness. This must include the welds connecting the roof to the rim angles and trusses.

Safety and security conditions:

Many safety requirements are set by Occupational Safety and Health Act (OSHA) and their latest requirements should be followed. While most OSHA requirements do not apply to political subdivisions, they do apply to privately owned firms hired to inspect, maintain and repair publicly owned facilities and are used as standards of safety by many courts. Publicly owned facilities should meet OSHA requirements to avoid liability issues, and more importantly, to protect people working on the storage facilities.

1. Older elevated water tanks, that do not have leg ladders but require maintenance workers to climb a tower leg are serious safety hazards. These must have properly constructed safe ladders installed.
2. Check ladder brackets to assure that enough are provided, that they are not damaged by corrosion and that they are secure to both the structure and the ladders.
3. Check all ladder rungs to assure that they are secure and not damaged by corrosion.
4. Check to see that all ladders (interior and exterior) are constructed to OSHA requirements and that adequate room exists between the storage structure and the ladder rungs (seven inches minimum). Replace any flimsy or improperly constructed ladders.
5. Make sure safety devices that incorporate life belts, friction brakes and sliding attachments are provided on all ladders and that they are properly secured and operate safely.
6. Cables, power conduits, antenna brackets or similar devices should not be attached to any ladder because they will obstruct the ladder and prevent the safe use of the ladder or its safety devices.
7. Ladders or sections of ladders having pitches greater than 90 percent are prohibited and must be replaced with properly constructed ladders or sections.
8. All cables and wires to devices on the storage structure must be installed inside properly constructed conduits. Properly designed brackets must safely secure the conduits to the storage structure.
9. Check catwalk railings and posts to make sure they are securely attached. All catwalks must have railings that meet OSHA construction regulations. The intent of OSHA regulations is to have railings that do more than prevent people from falling. They must also prevent equipment, work material and other objects from falling. Therefore, the spacing between railings must meet standards and toe plates must be provided.
10. Check the condition of all landings and catwalks to make sure they are clean, that they drain properly and are not damaged by corrosion.
11. Large diameter wet risers in the bottom of elevated tanks are fall hazards so guardrails must be installed to protect people from falling into the riser. Grates over the riser tops do not meet

OSHA standards, are easily damaged and displaced by ice and are dangerous to repair. If the wet riser pipe is extended into the tank for this purpose, it must meet the same criteria as a guard rail system (extend a minimum of 42-inches, have a top rail that can be gripped, etc.).

12. All water storage structures must have at least two access ways such that when ventilation equipment blocks one, the other is free from obstruction. Elevated water tanks must have at least two access ways in the tank portion of the structure and the manway in the riser does not count. The number of manways required depends on the size of the facility and is specified by OSHA.
13. Check to see that all manways are large enough (24-inches in diameter minimum).
14. Check all painters rings and brackets to assure they are sound, securely attached and not excessively corroded.
15. Inspect all Federal Aviation Administration warning lights to see that they are working properly.

Security Issues:

1. On elevated water tanks, standpipes and tall ground storage facilities, exterior ladders must terminate at least eight feet above ground and have their bottom sections covered with locking ladder guards.
2. Access to water storage structures must be restricted to only authorized people. Therefore, the tower site should be properly fenced. Check to see that security fences are sound and that their gates and locks work properly.
3. Check to see that all doors and access hatches are locked.

Coating system conditions:

The following things should be done when inspecting the coating systems on a storage facility and explained in the facility inspection report.

1. Determine the type and general condition of the interior and exterior paint systems. Determine lead and chromium levels on any paint that appears to be high in lead or chromium.
2. If rusting is continuous, approximate the percent of rusted area and determine the character of the areas (loose paint, blotchy, general corrosion, no paint).
3. Determine the extent, nature and depth of pitting.
4. Determine total system film thickness and run adhesion tests.
5. Check the paint for chalking and blistering.
6. Determine surface profiles.
7. Concrete structures should be inspected for signs of concrete deterioration (spalling, cracking, leaking, etc.).
8. Glass coated structures should be inspected for cracking, corrosion and other signs of coating deterioration.

Inspection Frequency

The frequency of inspection of items in each category varies. Sanitary, safety, security and some structural conditions should be inspected every year. Coating system conditions should be inspected every two to five years. In addition, storage facilities should be cleaned every two to five years depending on silt build up. The frequency that general information is physically determined depends upon the quality of a system's records on the particular water storage facility. However, this information should be physically determined before doing any major repair work on the storage structure and before designing other storage facilities or major expansions to the water distribution system. Therefore, the type of firm hired, the equipment required and how a facility is drained and disinfected all depend upon the scope of the inspection and the items inspected. Finally, every system should keep inspection records on file for each storage facility and use them to decide the frequency and scope of inspections.

For more information

Missouri Department of Natural Resources
Water Protection Program
P.O. Box 176
Jefferson City, MO 65102-0176
1-800-361-4827 or (573) 751-1300 office
(573) 526-1146 fax
www.dnr.mo.gov/wpscd/wpcp